REMARKS

Claims 4-5, 9-10, 13, 16, 19-20, 22, and 24-28 are now pending in the application. Claims 4, 9, 13, and 16 have been amended, and new claims 25-28 added without introduction of new matter. Favorable reconsideration is respectfully requested in view of the above amendments and the following remarks.

Before addressing the specific issues raised in the Office Action, it is noted that the preambles of independent claims 4, 9, 13, and 16 have been amended merely to spell out the well-known abbreviation "RF." None of these amendments are believed to introduce new subject matter.

Claims 4-5, 9-10, 13, 16, 19-20, 22, and 24 again stand rejected under 35 U.S.C. §102(e) as allegedly being anticipated by Suga et al. (US Patent 6,771,708 B1). This rejection is respectfully traversed.

It is believed that a review of some background material underlying the various aspects of the invention will facilitate an appreciation for the differences between the claimed embodiments and the applied prior art. The invention relates to digital communications systems that use non-constant envelope modulation schemes, whereby some part of the information lies in the amplitude (envelope) of the transmitted signal and some part lies in the phase of the transmitted signal. In other words, this is a combination of Amplitude Modulation (AM) and Phase Modulation (PM). To deal with amplitude modulation, an output power amplifier in the radio transmitter needs to be linear, that is, the relationship between the output power of the power amplifier and the input power of the power amplifier needs to be linear for all possible power levels. Otherwise the result will be AM-to-AM distortion.

Similarly, to deal with the phase modulation, the phase shift through the power amplifier has to be constant for all possible power levels. Otherwise the result will be AM-to-PM distortion, that is, the phase shift of the power amplifier changes with the input amplitude.

The consequences of using a power amplifier with non-constant gain and/or non-constant phase shift will be amplitude distortion and/or phase distortion in the transmitted signal. Because such distortion can seriously degrade performance of the communication system, linearity is crucial for transmitter used in a digital modulation system with non-constant amplitude modulation. Moreover, high linearity requirements often lead to poor

power efficiency. To attain good linearity and good power efficiency, some linearization methods and/or some efficiency enhancement methods are often used. A problem that often arises, however, is poor time alignment in the modulated signal between the "information parameters" (or "information components"), i.e., between gain and phase (polar representation) or alternatively between I and Q (Cartesian representation). That is, if one assumes a polar representation, the magnitude (r) and phase (f) should be adjusted so that no time error exists between these two information components "at the antenna" (i.e., at the RF output of the RF transmitter). Similarly, if one instead uses a Cartesian representation, the "information components" will be represented by the Inphase (I) and Quadrature (Q) signals, and these two signals should be adjusted so that no time error exists between them "at the antenna".

The Application describes some embodiments that utilize polar representation. The solutions presented for such embodiments have the purpose of making sure that, at each moment and at the RF output of the transmitter, the magnitude values are associated with the phase values that they ideally should be associated with. (Note: In this context, the term "phase" refers to the phase in a polar baseband representation.)

The Application also describes some embodiments that utilize Cartesian representation. The solutions presented for such embodiments have the purpose of making sure that, at each moment and at the RF output of the transmitter, the Inphase values are associated with the Quadrature values that they ideally should be associated with.

In all embodiments, then, the goal is to ensure that the information that is transmitted does not become distorted or corrupted due to an erroneous timing difference between the information components (i.e., the timing between r and f, or alternatively between I and Q).

The variously claimed embodiments are directed to this purpose. As now amended, independent claim 4 defines a step of "adjusting the generated amplitude and phase signals", wherein that step comprises "detecting an output RF signal to produce detected amplitude and phase signals; delaying the generated phase signal by a first time delay amount to produce a delayed phase signal, the first time delay amount being such as to minimize a difference between the delayed phase signal and the detected phase signal; delaying the generated amplitude signal by a second time delay amount to produce a delayed amplitude signal, the second time delay amount being such as to minimize the difference between the delayed amplitude signal and the detected amplitude signal; <u>using the first and second time</u>

delay amounts to determine a third time delay amount and a fourth time delay amount; and adjusting the generated phase signal in dependence upon the third time delay amount to produce the adjusted phase signal and adjusting the generated amplitude signal in dependence upon the fourth time delay amount to produce the adjusted amplitude signal, *wherein the third and fourth time delay amounts together are such as to compensate for a time delay between the detected phase and detected amplitude signals.*" (Emphasis added.)

Independent claim 9 as similarly amended, defines a step of "adjusting the generated inphase and quadrature (I and Q) signals", where that step comprises "detecting an output RF signal to produce detected inphase and quadrature (I and Q) signals; delaying the generated inphase (I) signal by a first time delay amount to produce a delayed inphase (I) signal, the first time delay amount being such as to minimize a difference between the delayed inphase (I) signal and the detected inphase (I) signal; delaying the generated quadrature (Q) signal by a second time delay amount to produce a delayed quadrature (Q) signal, the second time delay amount being such as to minimize the difference between the delayed quadrature (Q) signal and the detected quadrature (Q) signal; using the first and second time delay amounts to determine a third time delay amount and a fourth time delay amount; and adjusting the generated inphase (I) signal in dependence upon the third time delay amount to produce the adjusted inphase (I) signal and adjusting the generated quadrature (Q) signal in dependence upon the fourth time delay amount to produce the adjusted quadrature (Q) signal, *wherein the third and fourth time delay amounts together are such as to compensate for a time delay between the detected inphase (I) and detected quadrature (Q) signals*." (Emphasis added.)

As now amended, independent claim 13 defines an apparatus for adjusting timing of phase and amplitude components of an RF signal, the apparatus comprising, *inter alia*, "a delay unit connected to receive the generated phase and amplitude signals and operable to delay those signals by respective first and second time delays to produce delayed phase and amplitude signals, the first time delay being determined such that differences between detected and delayed phase signals are minimized, and the second time delay being determined such that differences between detected and delayed amplitude signals are minimized; and a delay calculation unit which is operable to generate the first and second adjustment control signals in dependence upon the first and second time delays and to supply the first and second adjustment control signals to the adjustment unit, *wherein the first and second adjustment control signals together are such as to cause the adjustment unit to*

compensate for a time delay between the detected phase and detected amplitude signals." (Emphasis added.)

Independent claim 16, as now amended, defines an apparatus for adjusting timing of inphase and quadrature (I and Q) components of an RF signal, the apparatus comprising, *inter alia*, "a delay unit connected to receive the generated inphase and quadrature (I and Q) signals and operable to delay those signals by respective first and second time delays to produce delayed inphase and quadrature (I and Q) signals, the first time delay being determined such that differences between detected and delayed inphase (I) signals are minimized, and the second time delay being determined such that differences between detected and delayed quadrature (Q) signals are minimized; and a delay calculation unit which is operable to generate the first and second adjustment control signals in dependence upon the first and second time delays and to supply the first and second adjustment control signals to the adjustment unit, *wherein the first and second adjustment control signals together are such as to cause the adjustment unit to compensate for a time delay between the detected inphase (I) and detected quadrature (Q) signals.*" (Emphasis added.)

These amendments do not add new matter, and more expressly emphasize that separate time delays are applied (one for phase or I signals, and another for amplitude or Q signals), and that these separate time delays are derived differently and therefore need not be equal to one another. Support for these amendments is found throughout the specification. For example, Figure 1 illustrates how a first time delay (d_1) is generated for the phase signal, and a second time delay (d_2) is generated for the amplitude signal. This figure further illustrates how a third time delay (d_φ) is generated (see block 12) from the first and second time delays (d_1 and d_2) for the purpose of controlling the delay of the generated phase signal (see block 14). This figure additionally illustrates how a fourth time delay (d_r) is generated (see block 12) from the first and second time delays (d_1 and d_2) for the purpose of controlling the delay of the generated amplitude signal (see block 16). Figure 5 provides similar support for embodiments that deal with Cartesian representations of the signals.

Support for the fact that "the first and second adjustment control signals together are such as to cause the adjustment unit to compensate for a time delay between the detected phase and detected amplitude signals" (polar embodiments) may be found in the specification at, for example, page 7, lines 11-14. Support for the fact that "the first and second adjustment control signals together are such as to cause the adjustment unit to compensate for a time

delay between the detected inphase (I) and detected quadrature (Q) signals" (Cartesian embodiments) may be found in the specification at, for example, at page 9, lines 2-5.

The Suga et al. patent fails to anticipate any of independent claims 4, 9, 13, and 16 at least because it neither discloses nor suggests:

- delaying the generated phase (or inphase "I") signal by a first time delay amount to produce a delayed phase signal, the first time delay amount being such as to minimize a difference between the delayed phase (or I) signal and the detected phase (or I) signal;
- delaying the generated amplitude (or quadrature phase "Q") signal by a second time delay amount to produce a delayed amplitude (or Q) signal, the second time delay amount being such as to minimize the difference between the delayed amplitude (or Q) signal and the detected amplitude (or Q) signal;
- using the first and second time delay amounts to determine a third time delay amount and a fourth time delay amount;
- adjusting the generated phase (or I) signal in dependence upon the third time delay amount to produce the adjusted phase (or I) signal and adjusting the generated amplitude (or Q) signal in dependence upon the fourth time delay amount to produce the adjusted amplitude (or Q) signal; and
- the third and fourth time delay amounts together being such as to compensate for a time delay between the detected phase (or I) and detected amplitude (or Q) signals.

Instead, the Suga et al. patent describes a method for compensating for non-linear performance in the power amplifier. In contrast to Applicant's variously claimed embodiments, the Suga et al. patent only describes means for adjusting the time delay between pairs of signals (each signal comprising phase and amplitude components, or equivalently I and Q components), for example the time delay between one signal I1, Q1 and another signal I3, Q3. That is, Suga et al. describe delaying I1 and Q1 by the same amount, say Δt, so that $I3(t) = I1(t-\Delta t)$ and $Q3(t) = Q1(t-\Delta t)$. (See, e.g., Suga et al. at column 5, lines 18-21.) This is further evident in Suga et al.'s Figure 2, for example, where it can be seen that the delay controller 47 supplies the same control signal to each of the RAM delay units 31, 32, so that they will delay I3 and Q3 by the same amount.

By contrast, the exemplary embodiments depicted in Applicant's FIGS. 1 and 2 (for polar embodiments) include components 12, 14, and 16 that separately derive and apply different time delays to the phase and amplitude signals. Similarly, for Cartesian embodiments, Applicant's FIGS. 5 and 6 show that components 12, 22, and 24 separately derive and apply different time delays to the I and Q signals.

It is evident, then, that some of Applicant's variously claimed embodiments provide means for (assuming two signal pairs {I1, Q1} and {I2, Q2}) adjusting the time delay between I1 and Q1, and the time delay between I2 and Q2. In others of Applicant's variously claimed embodiments, in which two polar signal pairs (for convenience call them {Magn1, Phase1}, {Magn2, Phase2}) are involved, means are provided for adjusting the time delay between Magn1 and Phase1, and between Magn2 and Phase2.

These characteristics are reflected in each of Applicant's claims by the definitions of the "third time delay amount" (alternatively "first adjustment control signal") and the "third time delay amount" (alternatively "second adjustment control signal") and the further recitations that define to what signals these delays are respectively applied.

For at least the foregoing reasons, independent claims 4, 9, 13, and 16 are believed to be patentably distinguishable over the Suga et al. patent. The remaining claims 5, 10, 19, 20, 22, and 24, variously depend from independent claims 4, 9, 13, and 16, and are therefore patentable for at least the same reasons as those set forth above. Therefore, it is respectfully requested that the rejection of claims 4-5, 9-10, 13, 16, 19-20, 22, and 24 under 35 USC §102(e) be withdrawn.

New claims 25-28 have been added without introduction of new matter. Support for these claims may be found in the specification at, *inter alia*, page 6, lines 18-20 and 29-32; and at page 8, lines 28-32. These claims are believed to be patentable over the prior art of record at least because that art neither discloses nor suggests:

- measuring a first delay amount that represents an amount by which a phase (or inphase I) signal is delayed by RF circuitry that generates the output RF signal;
- measuring a second delay amount that represents an amount by which an amplitude (or quadrature Q) signal is delayed by the RF circuitry that generates the output RF signal;
- generating a third delay amount based on a comparison between the first and second delay amounts;

- generating a fourth delay amount based on a comparison between the first and second delay amounts; and
- the third and fourth time delay amounts together being such as to compensate for a time delay between an output phase (or I) component of the RF signal and an output amplitude (or Q) component of the output RF signal.

The application is believed to be in condition for allowance. Prompt notice of same is respectfully requested.

Respectfully submitted,
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